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Fort Collins, Colorado 80527-2400

PATENT APPLICATION

ATTORNEY DOCKET NO. 200309593-1

IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Peter Mardilovich et al.

Confirmation No.: 5931

Application No.: 10/629,116

Examiner: LEE, Cynthia K.

Filing Date: July 28, 2003

Group Art Unit: 1745

Title: Fuel Cell Support Structure and Method of Manufacture

Mail Stop Appeal Brief-Patents
Commissioner For Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEFTransmitted herewith is the Appeal Brief in this application with respect to the Notice of Appeal filed on February 5, 2007.

The fee for filing this Appeal Brief is (37 CFR 1.17(c)) \$500.00.

(complete (a) or (b) as applicable)

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136(a) apply.

☐ (a) Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d)) for the total number of months checked below:

☐ 1st Month
\$120

☐ 2nd Month
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☐ 3rd Month
\$1020

☐ 4th Month
\$1590

☐ The extension fee has already been filed in this application.

☒ (b) Applicant believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

Please charge to Deposit Account 08-2025 the sum of \$ 500 . At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 CFR 1.25. Additionally please charge any fees to Deposit Account 08-2025 under 37 CFR 1.16 through 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees. A duplicate copy of this sheet is enclosed.

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Respectfully submitted,

Peter Mardilovich et al.

By 

Steven L. Nichols

Attorney/Agent for Applicant(s)

Reg No. : 40,326

Date : April 7, 2007

Telephone : (801) 572-8086


Application No.: 10/629,116

Attorney Docket No.: 200309593-1

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1. Transmittal of Appeal Brief with Duplicate Copy (2 pages)
2. Certificate of Transmission (1 page)
3. Appeal Brief (26 pages)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Patent Application of

Peter Mardilovich et al.

Application No. 10/629,116

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For: Fuel Cell Support Structure
and Method of Manufacture

Group Art Unit: 1745

Examiner: LEE, Cynthia K.

APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
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Alexandria, VA 22313-1450

Sir:

This is an Appeal Brief under Rule 41.37 appealing the decision of the Primary Examiner dated December 15, 2006 (the "final Office Action"). Each of the topics required by Rule 41.37 is presented herewith and is labeled appropriately.

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I. Real Party in Interest

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

II. Related Appeals and Interferences

There are no appeals or interferences related to the present application of which the Appellants are aware.

III. Status of Claims

Claims 49-84 are pending in the application and stand finally rejected. Accordingly, Appellant appeals from the final rejection of claims 49-84, which claims are presented in the Appendix.

IV. Status of Amendments

No amendments have been filed subsequent to the final Office Action of December 15, 2006, from which Appellant takes this appeal.

V. Summary of Claimed Subject Matter

Fuel cells conduct an electrochemical reaction with reactants such as hydrogen and oxygen to produce electricity and heat. (*Appellant's specification, paragraph 0001*). A

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typical fuel cell includes an electrolyte disposed between an anode and a cathode. (*Appellant's specification, paragraph 0002*). Appellant's specification describes a fuel cell support structure for the anode, cathode and electrolyte, and methods for fabricating fuel cell support structures. According to one exemplary implementation, a fuel cell support structure includes a self-organized ceramic substrate in which nanopores of selected morphology are defined. (*Appellant's specification, paragraph 0024*).

With reference to Appellant's Fig. 1, a fuel cell (100) generally includes a support structure (110), an electrolyte (120), an anode (130), and a cathode (140). The fuel cell support structure (110) supports the electrolyte (120), the anode (130), and/or the cathode (140). Fig. 1 illustrates an exemplary implementation of a dual chamber fuel cell (100) utilizing a self-organized nanoporous ceramic fuel cell support structure (110). As used herein, the term "self-organized" refers to the property of the material from which the support structure is made to form parallel nanopores when the support substrate is grown, micromachined or etched as described below. The support structure may be formed, for example, from anodic alumina. In the illustrated implementation, a dense layer of electrolyte (120) is disposed in the pores (150) in the support structure (110). Further, the anode (130) and the cathode (140) are disposed on opposing sides of the support structure (110), being separated by the support structure (110) and the deposited electrolyte (120). Thus, the combination of the support structure, the electrolyte (120), the anode (130) and the cathode (140) separate the two chambers of the fuel cell system (not shown). The structure and operation of the dual chamber fuel cell will be described in more detail below with reference to Figs. 9-11. For dual chamber systems, efficiency may be affected by the need to seal two chambers from each other and by the ability to transfer ions from the cathode across the electrolyte to the anode. Precise control of the porosity characteristics of a support structure

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may allow for more precise formation of the electrolyte and/or electrodes on the support structure while providing for improved diffusion. (*Appellant's specification, paragraph 026*)

Turning to specific claims:

Claim 49 recites:

A fuel cell comprising:

a ceramic support substrate (110) supporting a cathode (140), anode (130) and electrolyte (120) (*Appellant's specification, paragraph 026*); and

a plurality of pores (150) formed through said substrate (110), said pores (150) having a size that varies in diameter through a thickness of said substrate (110) (*Appellant's specification, paragraph 0036 and Figs. 6 and 7*).

Claim 51 recites:

A fuel cell comprising:

a support substrate (110) supporting a cathode (140), anode (130) and electrolyte (120) (*Appellant's specification, paragraph 026*); and

a plurality of pores (150) formed through said substrate (110) (*Appellant's specification, paragraph 026*),

wherein said pores (150) vary in diameter by tapering to a narrow point (600) between two openings, both openings being larger than said narrow point (*Appellant's specification, paragraph 0036 and Figs. 6 and 7*).

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Claim 58 recites:

An apparatus comprising:

a fuel cell configured for providing power (*Appellant's specification, paragraph 026*), said fuel cell comprising:

a support substrate (110) supporting a solid cathode material (140) deposited on a first side of said substrate (110), a solid anode material (130) deposited on a second side of said substrate (110) and an electrolyte (120) (*Appellant's specification, paragraph 026*); and

a plurality of pores (150) formed through said substrate (110), said pores (150) having a size and shape formed in accordance with a pre-selected desired porosity (*Appellant's specification, paragraph 026*).

VI. Grounds of Rejection to be Reviewed on Appeal

The final Office Action raised the following grounds of rejection:

- (1) Claims 55 and 57 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite.
- (2) Claims 58, 59, 65, 66, 68, 69, 76, 77, and 78 were rejected as anticipated under 35 U.S.C. § 102(b) by U.S. Patent No. 3,503,808 to Agruss ("Agruss").
- (3) Claims 49, 58, 72, 74, 75, 81, 83 and 84 were rejected as anticipated under 35 U.S.C. § 102(b) by U.S. Patent App. Pub. No. 2005/0196657 to Sarkar ("Sarkar").
- (4) Claims 49-57, 60-64 and 67-69 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of Agruss and U.S. Patent App. Pub. No. 2002/01422414 to Pekala et al. ("Pekala").

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(5) Claims 70, 71, 73, 79, 80 and 82 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of Sarkar and U.S. Patent No. 6,558,831 to Doshi ("Doshi").

Accordingly, Appellant hereby requests review of these grounds of rejection.

VII. Argument

(1) Claims 55 and 57 comply with 35 U.S.C. § 112, second paragraph

Claims 55 and 57 were rejected as indefinite under 35 U.S.C. § 112, second paragraph, due to the inclusion of the word "substantially." (Action of 12/15/06, p. 2). Specifically, claim 55 recites "wherein said pores are substantially uniform in size and shape." Claim 57 recites "wherein said substrate comprises a second plurality of substantially uniform pores formed through said substrate wherein an average size of said second plurality of pores is smaller than said first plurality of pores."

One of skill in the art would appreciate that the formation of pores on a micro or nano scale using an anodic growth process, with or without subsequent micro-machining, is not reasonably likely to result in perfectly uniform pores. (See, Appellant's specification, paragraphs 0029 and 0030). However, one of skill in the art would also appreciate that pores formed by a common process will have variations of size and shape only within the tolerances of that formation process.

Thus, one of skill in the art would readily understand the scope of claims 55 and 57 as referring to pores that are formed using a common process and are thus "substantially," if not perfectly, uniform within the tolerances of that process. Thus, the scope of claims 55 and 57 would be clear and definite to one of ordinary skill in the art. For this reason, the rejection of claims 55 and 57 should not be sustained.

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(2) Claims 58, 59, 65, 66, 68, 69, 76, 77, and 78 are Patentable over Agruss:

Claim 58:

Claim 58 recites:

An apparatus comprising:
a fuel cell configured for providing power, said fuel cell comprising:
a support substrate supporting *a solid cathode material* deposited on a first side of said substrate, *a solid anode material* deposited on a second side of said substrate and an electrolyte; and
a plurality of pores formed through said substrate, said pores having a size and shape formed in accordance with a pre-selected desired porosity.
(Emphasis added).

In contrast, Agruss fails to teach or suggest the claimed porous substrate supporting a *solid* cathode material and a *solid* anode material. In this regard, reference is made to Applicant's originally-filed specification at, for example, paragraph 0039.

To the contrary, Agruss teaches away from this subject matter with a very different fuel cell chemistry in which the electrodes are *liquid*. (Agruss, col. 2, lines 25-30). Clearly, one of skill in the art can tell the difference between a solid electrode material, as claimed, and a liquid electrode material, as taught by Agruss.

"A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987) (emphasis added). See M.P.E.P. § 2131. For at least these reasons, the rejection of claims 58 and 59 should not be sustained.

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Claims 68 and 69:

Appellant notes that claims 68 and 69 depend from independent claim 49, which is not included in this rejection based on Agruss. Consequently, the inclusion of claims 68 and 69 in this rejection is clearly improper and cannot be sustained

Claim 76:

Claim 76 recites "wherein said fuel-cell is a single chamber fuel cell." In contrast, Agruss clearly does not teach or suggest this subject matter.

Although not strictly at issue in this appeal, the Examiner does not understand the difference between a single versus a double chamber fuel cell. (Action of 12/15/06, p. 2). Nevertheless, the terms "single chamber" and "dual chamber" are well-defined and widely understood in the fuel cell art. In a dual chamber fuel cell, the fuel and the anode are sealed in a first chamber separate from the oxidant and cathode which are sealed in a second chamber. Typically, the electrolyte of the fuel cell provides an interface between the anode and cathode, and between the two chambers. In a single chamber fuel cell, the fuel and oxidant are allowed to mix and the mixture is supplied to both the anode and cathode simultaneously. This commonly-understood distinction is referenced and described in, for example, paragraphs 0026 and 0027 of the specification and illustrated in, for example, Figs. 11 (dual chamber) and 12 (single chamber). Thus, it is entirely unclear to Appellant why one of skill in the art would have any confusion regarding the description of both single chamber and dual chamber fuel cell configurations in Applicant's specification.

Given this explanation, it becomes inescapably clear that Agruss does not teach or suggest the single chamber fuel cell recited in claim 76. Understanding that Agruss teaches liquid electrodes, rather than solid electrodes, it would be impossible for Agruss to combine

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the liquid anode, liquid cathode, fuel and oxidant in a single chamber as recited in claim 76 and have a functional device. For at least these additional reasons, this rejection of claim 76 should not be sustained.

Claim 78:

Claim 78 recites "wherein each pore comprises a layer in which said electrolyte is mixed with a material of said substrate, said layer being between said electrolyte said substrate." In this regard, the final Office Action refers to Agruss at col. 3, lines 1-5. (Action of 12/15/06, p. 4). At this point, Agruss teaches that the potassium chloride electrolyte is molten at the operating temperatures of the fuel cell. The Office Action then appears to make the wholly unsupported assumption that the molten potassium chloride mixes or alloys with the alumina material of the separator (14) in a manner read on by claim 78. However, there is no such teaching or suggestion in Agruss, nor is such an assumption reasonable. For at least these additional reasons, this rejection of claim 78 should not be sustained.

(3) Claims 49, 58, 72, 74, 75, 81, 83 and 84 are Patentable over Sarkar:

Claim 49:

Claim 49 recites:

A fuel cell comprising:
a ceramic support substrate supporting a cathode, anode and electrolyte; and
a plurality of pores formed through said substrate, said pores having a size that varies in diameter through a thickness of said substrate.

Appellant notes that claim 49 recites a ceramic support *substrate* for cathode, anode and electrolyte with a plurality of pores formed through that substrate, the pores having a size that

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varies in diameter through the thickness of the substrate. This subject matter is not taught or suggested by Sarkar.

The structure of the fuel cell stack taught by Sarkar is entirely different than that claimed. Sarkar does not teach or suggest a support substrate, ceramic or otherwise, that supports a cathode, anode and electrolyte of a fuel cell. Rather, Sarkar teaches solid oxide fuel cells that are formed as tubes. (Sarkar, abstract). The cathode may be formed on the outer or inner surface of the tube, with the anode on the other surface of the tube. (Sarkar, paragraphs 0075 and 0082).

Because there is *no supporting substrate*, the tubular fuel cells are extremely fragile. (Sarkar, paragraph 0078). This is a principal concern of Sarkar. Consequently, Sarkar teaches embedding these tubular fuel cells in a block of material referred to as a matrix (20). (Sarkar, paragraph 0078). In order for the fuel cells to operate, the matrix is porous to allow the passage of fuel and oxidant to the embedded fuel cells. (Sarkar, paragraph 0082).

Consequently, Sarkar fails to teach or suggest the claimed "ceramic support *substrate* supporting a cathode, anode and electrolyte." (Emphasis added). To the contrary, Sarkar teaches embedding tubular fuel cells in a matrix material rather than providing the claimed support substrate.

In addition to not being a substrate as claimed, the matrix material taught by Sarkar is also not a ceramic substrate having "a plurality of pores formed through said substrate, said pores having a size that varies in diameter through a thickness of said substrate." Such a description is meaningless within the context of Sarkar's matrix material that surrounds the tubular fuel cells.

Rather, Sarkar teaches a ceramic or cermet "wool" bundle in which the tubular fuel cells are embedded. (Sarkar, claim 5). In such a wool bundle, there are no defined pores

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through a thickness of a substrate as claimed. Rather, there is simply space between the fibers of the wool bundle that allow fuel or oxidant to diffuse in many directions through the "porous" fabric of the wool bundle to reach the embedded fuel cells. Consequently, Sarkar cannot teach or suggest the claimed "plurality of pores formed through said substrate, said pores having a size that varies in diameter through a thickness of said substrate."

"A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987) (emphasis added). See M.P.E.P. § 2131. For at least these reasons, this rejection of claim 49 should not be sustained.

Claim 58:

Claim 58 recites:

An apparatus comprising:
a fuel cell configured for providing power, said fuel cell comprising:
a support substrate supporting a solid cathode material deposited on a first side of said substrate, a solid anode material deposited on a second side of said substrate and an electrolyte; and
a plurality of pores formed through said substrate, said pores having a size and shape formed in accordance with a pre-selected desired porosity.

As explained above, Sarkar does not teach or suggest a support substrate as claimed. The insufficient final Office Action does not explain how Sarkar is thought to teach or suggest the claim support substrate recited in claim 58. For this reason alone, this rejection of claim 58 should not be sustained.

As also noted above, rather than a support substrate, Sarkar teaches a matrix material that surrounds tubular fuel cell structures. Consequently, Sarkar does not, and cannot, teach or suggest the claimed "support substrate supporting a solid cathode material deposited on a

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first side of said substrate, a solid anode material deposited on a second side of said substrate and an electrolyte."

"A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987) (emphasis added). See M.P.E.P. § 2131. For at least these reasons, this rejection of claim 58 should not be sustained.

(4) Claims 49-57, 60-64 and 67-69 are Patentable over Agruss and Pekala:

Claim 49:

Claim 49 recites:

A fuel cell comprising:
a ceramic support substrate supporting a cathode, anode and electrolyte; and
a plurality of pores formed through said substrate, said pores having a size that varies in diameter through a thickness of said substrate.

In contrast, the combination of Agruss and Pekala fails to teach or suggest the claimed ceramic support substrate in a fuel cell with a plurality of pores formed through the substrate "having a size that varies in diameter through a thickness of said substrate."

Agruss teaches a porous alumina substrate, but absolutely does not teach or suggest that pores in the substrate have a size that varies in diameter through thickness of the substrate. Pekala teaches a "polymer web" for use in forming an electrode assembly. (Pekala, abstract). While the pores in the polymer web taught by Pekala are irregular in shape (see, Pekala, Figs. 4a and 4b), this has no impact on or relevance to the pores in the *alumina* substrate taught by Agruss.

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Just because there are irregularly shaped pores in the polymer web of Pekala, that does not mean one of skill in the art would have been lead to want such irregular pores in an alumina substrate such as that taught by Agruss. "Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed Cir. 1992)." *M.P.E.P. § 2143.01 (emphasis added).

More importantly, the prior art does not teach one of skill in the art how to form such variable diameter pores in the alumina substrate of Agruss. "In order to render a claimed apparatus or method obvious, the prior art must enable one skilled in the art to make and use the apparatus or method." *Beckman Instruments, Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551, 13 U.S.P.Q.2d 1301, 1304 (Fed. Cir. 1989); *In re Payne*, 606 F.2d 303, 314, 203 U.S.P.Q. 245, 255 (CCPA 1979).

Consequently, it is unreasonable to suggest that Agruss and Pekala either suggest or enable the subject matter of claim 49 to one of skill in the art. Agruss and Pekala do not together suggest the claimed pores of variable diameter in a *ceramic* substrate. Moreover, one of skill in the art would not be able to produce such pores in a ceramic substrate based on the teachings of Agruss and Pekala. For at least these reasons, this rejection of claim 49 should not be sustained.

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Claim 51:

Claim 51 recites:

A fuel cell comprising:
a support substrate supporting a cathode, anode and electrolyte; and
a plurality of pores formed through said substrate,
wherein said pores vary in diameter by tapering to a narrow point between two
openings, both openings being larger than said narrow point.

In contrast, the combination of Agruss and Pekala does not teach or suggest a fuel cell with a porous support substrate in which "said pores vary in diameter by tapering to a narrow point between two openings, both openings being larger than said narrow point." This subject matter is illustrated, for example, in Figs. 6 and 7 of the Applicant's originally-filed specification.

In this regard, the final Office Action concedes that "Agruss does not disclose the specifics of the pores." (Action of 12/15/06, p. 6). Consequently, the Action cites to Pekala. (*Id.*). However, the Action misstates and apparently misapprehends what claim 51 recites. According to the Action, "Pekala discloses a porous substrate with pores that vary in diameter along a thickness of the substrate (applicant's claim 51)." (*Id.*).

This, however, is clearly not what claim 51 recites. Claim 51 recites "a porous support substrate in which "said pores vary in diameter by tapering to a narrow point between two openings, both openings being larger than said narrow point." As noted, this subject matter is illustrated, for example, in Figs. 6 and 7 of the Appellant's originally-filed specification.

Consequently, the Office Action fails to actually address claim 51 or make a *prima facie* case of unpatentability as to claim 51. Moreover, Pekala does not teach or suggest the tapering pores with a narrow point between two larger openings as recited in claim 51. (*See*, Pekala, Figs. 4a and 4b).

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"To establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974)." M.P.E.P. § 2143.03. Accord. M.P.E.P. § 706.02(j). For at least these reasons, the rejection of claim 51 should not be sustained.

Claim 52:

Claim 52 depends from claim 49 and recites "wherein said pores branch within said substrate." Appellant notes that claim 49 specifies that the branching pores are in a *ceramic* substrate.

With regard to claim 52, the Office Action refers to the teachings of Pekala. (Action of 12/15/06, p. 6). However, as noted above, Pekala teaches pores in a polymer web and not in a ceramic substrate.

There is no reference of record that teaches or suggests the claimed pores that branch within a *ceramic* substrate as recited in claim 52. Consequently, for at least this additional reason, the rejection of claim 52 and its dependent claims should not be sustained.

Claim 53:

Claim 53 recites "wherein branching of said pores results in a greater number of pore openings on a first side of said substrate than on a second side of said substrate." Again, this is with respect to a ceramic substrate. For the reasons given above with respect to claim 52, the combination of Agruss and Pekala fails to teach or suggest this subject matter and the rejection of claim 53 should not be sustained.

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Claim 57:

Claim 57 recites "wherein said substrate comprises a second plurality of substantially uniform pores formed through said substrate wherein an average size of said second plurality of pores is smaller than said first plurality of pores." Again, this is with respect to a ceramic substrate.

None of the cited prior art references teach or suggest two pluralities of pores where an average size of one plurality of pores is smaller than that of the other plurality of pores. For at least this additional reason, the rejection of claim 57 should not be sustained.

Claims 60-64 and 67:

Appellant notes that claims 60-64 and 67 depend from independent claim 58, which was not included in this rejection based on a combination of the teachings of Agruss and Pekala. Consequently, the inclusion of claims 60-64 and 67 in this rejection without their independent claim is clearly improper and cannot be sustained.

Claim 69:

Claim 69 recites "wherein each pore comprises a layer in which said electrolyte is mixed with a material of said substrate, said layer being between said electrolyte said substrate." The deficient final Office Action fails to address how Agruss and Pekala teach or suggest this subject matter. Consequently, no *prima facie* case of unpatentability has been made and this rejection of claim 69 should not be sustained.

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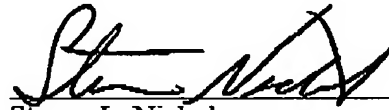
(5) Claims 70, 71, 73, 79, 80 and 82 are patentable over Sarkar and Doshi:

These claims are patentable over the combination of Sarkar and Doshi for the same reasons given above with respect to the patentability of claims 49 and 58. Therefore, this rejection should not be sustained.

In view of the foregoing, it is submitted that the final rejection of the pending claims is improper and should not be sustained. Therefore, a reversal of the Rejection of December 15, 2006 is respectfully requested.

Respectfully submitted,

DATE: April 4, 2007


Steven L. Nichols
Registration No. 40,326

Steven L. Nichols, Esq.
Managing Partner, Utah Office
Rader Fishman & Grauer PLLC
River Park Corporate Center One
10653 S. River Front Parkway, Suite 150
South Jordan, Utah 84095
(801) 572-8066
(801) 572-7666 (fax)

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VIII. CLAIMS APPENDIX

1-48. (cancelled)

49. (previously presented) A fuel cell comprising:

a ceramic support substrate supporting a cathode, anode and electrolyte; and

a plurality of pores formed through said substrate, said pores having a size that varies in diameter through a thickness of said substrate.

50. (original) The fuel cell of claim 49, wherein said electrolyte is deposited in said pores.

51. (previously presented) A fuel cell comprising:

a support substrate supporting a cathode, anode and electrolyte; and

a plurality of pores formed through said substrate,

wherein said pores vary in diameter by tapering to a narrow point between two openings, both openings being larger than said narrow point.

52. (original) The fuel cell of claim 49, wherein said pores branch within said substrate.

53. (previously presented) The fuel cell of claim 52, wherein branching of said pores results in a greater number of pore openings on a first side of said substrate than on a second side of said substrate.

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54. (original) The fuel cell of claim 53, wherein said anode is disposed on said first side of said substrate and said cathode is disposed on said second side of said substrate.

55. (previously presented) The fuel cell of claim 49, wherein said pores are substantially uniform in size and shape.

56. (original) The fuel cell of claim 49, wherein said substrate comprises alumina.

57. (previously presented) The fuel cell of claim 55, wherein said substrate comprises a second plurality of substantially uniform pores formed through said substrate wherein an average size of said second plurality of pores is smaller than said first plurality of pores.

58. (previously presented) An apparatus comprising:
a fuel cell configured for providing power, said fuel cell comprising:
a support substrate supporting a solid cathode material deposited on a first side of said substrate, a solid anode material deposited on a second side of said substrate and an electrolyte; and
a plurality of pores formed through said substrate, said pores having a size and shape formed in accordance with a pre-selected desired porosity.

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59. (original) The apparatus of claim 58, wherein said electrolyte is deposited in said pores.

60. (original) The apparatus of claim 58, wherein said pores vary in diameter along a thickness of said substrate.

61. (original) The apparatus of claim 58, wherein said pores branch within said substrate.

62. (original) The apparatus of claim 61, wherein branching of said pores results in a greater number of pore openings on a first side of said substrate than on a second side of said substrate.

63. (original) The apparatus of claim 62, wherein said anode is disposed on said first side of said substrate and said cathode is disposed on said second side of said substrate.

64. (original) The apparatus of claim 58, wherein said pores are formed in parallel through said substrate.

65. (original) The apparatus of claim 58, wherein said substrate comprises a ceramic.

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66. (original) The apparatus of claim 58, wherein said substrate comprises alumina.

67. (original) The apparatus of claim 58, wherein said substrate comprises a second plurality of pores formed through said substrate wherein an average size of said second plurality of pores is smaller than said first plurality of pores.

68. (previously presented) The fuel cell of claim 49, wherein said pores provide an open passageway through said substrate with said electrolyte being deposited on sides of interiors of said pores.

69. (previously presented) The fuel cell of claim 68, wherein each pore comprises a layer in which said electrolyte is mixed with a material of said substrate, said layer being between said electrolyte said substrate.

70. (previously presented) The fuel cell of claim 49, wherein said cathode comprises perovskite.

71. (previously presented) The fuel cell of claim 70, wherein said cathode comprises lanthanum manganite.

72. (previously presented) The fuel cell of claim 49, wherein said anode comprises a ceramic/metal composite.

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73. (previously presented) The fuel cell of claim 72, wherein said anode comprises nickel and yttria-stabilized zirconia cermet.

74. (previously presented) The fuel cell of claim 49, wherein said electrolyte comprises at a zirconia-based electrolyte.

75. (previously presented) The fuel cell of claim 74, wherein said electrolyte comprises at least one of yttria-stabilized zirconia, gadolinium-doped ceria, $\text{Ba}_2\text{In}_2\text{O}_5$, or a (strontium, magnesium)-doped LaGaO_3 (LSGM).

76. (previously presented) The apparatus of claim 58, wherein said fuel-cell is a single chamber fuel cell.

77. (previously presented) The apparatus of claim 58, wherein said pores provide an open passageway through said substrate with said electrolyte being deposited on sides of interiors of said pores.

78. (previously presented) The apparatus of claim 77, wherein each pore comprises a layer in which said electrolyte is mixed with a material of said substrate, said layer being between said electrolyte said substrate.

79. (previously presented) The apparatus of claim 58, wherein said cathode comprises perovskite.

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80. (previously presented) The apparatus of claim 79, wherein said cathode comprises lanthanum manganite.

81. (previously presented) The apparatus of claim 58, wherein said anode comprises a ceramic/metal composite.

82. (previously presented) The apparatus of claim 81, wherein said anode comprises nickel and yttria-stabilized zirconia cermet.

83. (previously presented) The apparatus of claim 58, wherein said electrolyte comprises at a zirconia-based electrolyte.

84. (previously presented) The apparatus of claim 83, wherein said electrolyte comprises at least one of yttria-stabilized zirconia, gadolinium-doped ceria, $\text{Ba}_2\text{In}_2\text{O}_5$, or a (strontium, magnesium)-doped LaGaO_3 (LSGM).

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IX. Evidence Appendix

None

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X. Related Proceedings Appendix

None

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XI. Certificate of Service

None